IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

VERIFICATION OF TRANSLATION

Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

S. Edmund BERGER, residing at 298 Grayton Road, Tonawanda, NY 14150, declares:

(1) that he knows both the German and English languages well;

(2) that he translated the German document entitled "Switchable Assembly Bearing with Hydraulic Damping" from German to English;

(3) that the attached English Translation is a true and correct translation of the above-identified German document to the best of his knowledge and belief; and

(4) that all statements made of his knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements are made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and that such false statements may jeopardize the validity of the application or any patent issuing thereon.

Dated: October 26, 2004

Signed: _____

S. Edmund BERGER

(12) INTERNATIONAL APPLICATION PUBLISHED IN ACCORDANCE WITH THE INTERNATIONAL PATENT COOPERATION TREATY (PCT)

(19) World Organization for Intellectual Property International Office

[Logo:] WIPO OMPI

[Bar code]

(10) Internat. Publication No.: **WO 03/081080 A1**

(43) Internat. Publication Date October 2, 2003 (10.02.2003)

**PCT**

(51) Internat. Patent Classif.[7]: F16F 13/26

(21) Internat. File No.: PCT/EP03/03124

(22) Internat. Filing Date: March 26, 2003 (03.26.2003)

(25) Filing Language: German

(26) Publication Language: German

(30) Priority Data:
102 13 996.2 March 27 2002 (03.27.2002) DE

(71) Applicant: *(for all designated states except the US)*: **CARL FREUDENBERG KG** [DE/DE]; Höhnerweg 2-4, 69469 Weinheim (DE)

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **FREUDENBERG, Tillmann**; Ortstrasse 19, 64658 Fürth/Steinbach (DE), **MOOG, Erhard** [DE/DE]; Zur Waldwiese 5, 69517 Gorxheimertal (DE)

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CN, CO, CR, CU, CZ, DK, DM, DZ, EE, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, KE, KG, KP, KR, KZ, LC, LK, LR, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, RO, RU, LS, LT, LV, MA, MD,SD, SG, SK, SL, TJ, TM, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW

(84) Designated States *(regional)*: ARIPO pat. (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU TJ, TM), European pat. (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), AOPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declaration according to Rule 4.17:
- *Inventor declaration (Rule 4.17, item iv) for US only*

Published:
- *with Search Report*
- *before expiration of deadline for claim amendments; publication will be repeated if changes occur.*

*For an explanation of the two-letter code and of the other abbreviations, the reader is referred to the explanations ("Guidance Notes on Codes and Abbreviations" appearing at the beginning of every issue of the PCT Gazette.*

(54) Title: **SWITCHABLE ASSEMBLY BEARING WITH HYDRAULIC DAMPING**

(57) *Abstract:* The invention relates to a switchable assembly bearing (1) with hydraulic damping, especially for supporting drive and/or gearbox assemblies in motor vehicles. Said bearing comprises at least one working chamber (10) and one compensation chamber (20) which are separated by a dividing wall (50), but are hydraulically interconnected by means of a damping channel (60), in addition to at least one other damping channel (70) which can be closed

[Continued on next page]

by means of the sealed arrangement of a shut-off body (90) which can be displaced along a displacement path. According to the invention, the other damping channel is formed and arranged in relation to the axis of symmetry of the bearing in such a way that the forces acting on the shut-off body by means of the hydraulic fluid counterbalance each other. As a result, virtually no forces act on the shut-off body which can be moved back and forth between a closing position and an opening position by means of only few displacement forces, the actuating mechanism for the shut-off body being significantly simplified and also enabling a significantly simpler and more compact construction of the assembly.

Applicant: Carl Freudenberg KG, 69469 Weinheim

# Switchable Assembly Bearing with Hydraulic Damping

Description

## Technical Field

The invention relates to a switchable assembly bearing with hydraulic damping, particularly for supporting drive assemblies and/or gearbox assemblies in motor vehicles. Said bearing comprises at least one working chamber and one compensation chamber separated from one another by a dividing wall, but interconnected hydraulically by means of a damping channel, and at least one additional damping channel that can be closed by means of a shut-off body displaceable along a displacement path, said shut-off body being capable of providing sealing in cooperation with an associated seat.

## Prior Art

An assembly bearing of the said kind is known from, for example, DE 198 61 063 C2. The known assembly bearing has a working space and a compensation space with a dividing wall disposed between them. Moreover, between the working space and the compensation space the known assembly bearing comprises a damping channel for damping low-frequency, high-amplitude vibrations, and for isolating high-frequency, low-amplitude vibrations there is provided a membrane disposed in a recess and capable of moving back and forth in the direction of the vibrations introduced. In addition, the known assembly bearing is provided centrally within the dividing wall with an aperture that can be closed in a sealing manner by means of a shut-off body that is displaceable within the bearing and cooperates with an associated seat in the dividing wall.

In axial direction, the dividing wall consists of two parts and forms a membrane cage, the above-said membrane being disposed within the membrane cage. The above-said membrane is made of an elastomeric material, is circular in shape and has a central recess corresponding to the aperture.

For quenching of the vibrations caused during the idling of an attached internal combustion engine, the sealing body is removed from the aperture by downward axial displacement so that the liquid column can move within the aperture out of phase relative to the vibrations caused by the idling. This produces a quenching effect. During the operation of the internal combustion engine above the idling rotational speed, the aperture is closed by the sealing body, and under these operating conditions the bearing of the invention functions as do the generally known hydraulically damping bearings, in which, to isolate high-frequency, low-amplitude engine-induced vibrations, the membrane is disposed within the dividing wall so that it can move back and forth. For the damping of low-frequency, high-amplitude, roadway-induced vibrations, the damping liquid contained within the damping channel vibrates back and forth in an out-of-phase manner.

A drawback of the known assembly bearing is that the central aperture strongly reduces the surface area available for the membrane. This has a deleterious effect on the damping of low-amplitude, high-frequency acoustic vibrations. Moreover, in the central aperture the sealing body must be able to resist or move against the possibly increased pressure in the working space, which requires higher displacement forces. Other drawbacks are the complicated design of the known assembly bearing and the large dimensions thereof.

## Representation of the Invention

The object of the invention is to further develop an assembly bearing of the known kind in a manner such that it will be of simpler design and require a smaller mounting space and, in addition, reduced displacement forces for idling. This objective is reached with an assembly bearing having all the characteristics indicated in Claim 1. Advantageous embodiments of the invention are described in the subclaims.

The present invention makes use in simple manner of the symmetry of an assembly bearing relative to its long axis. According to the invention, in a switchable assembly bearing with hydraulic damping, particularly for the support of drive assemblies and/or gearbox assemblies in motor vehicles, comprising at least one working chamber and one compensation chamber that are separated by a dividing wall, but are hydraulically interconnected through a damping channel, and at least one additional damping channel that can be closed by a shut-off body displaceable along a displacement path and cooperating with an associated seat, the additional damping channel is configured and disposed relative to the symmetry axis of the bearing so that the forces acting on the shut-off body through the hydraulic liquid counterbalance each other. This has the advantage that substantially lower displacement forces are needed to displace the shut-off

body and, as a result, the assembly bearing can be of small and compact design.

In an advantageous embodiment of the invention, the damping channel is formed in simple manner as an annular slot extending radially around the aperture between the working chamber and the compensation chamber, with a passage opening disposed radially relative to the symmetry axis toward a corresponding annular slot-like connecting chamber leading to the compensation chamber. In this embodiment, the shut-off body is formed by a sealing ring displaceable back and forth along a displacement path extending vertical to the flow-through direction, namely parallel to the bearing axis, between an opening position and a closing position. With the described technical arrangement, by making use of the symmetry of the assembly bearing, it is possible to achieve in a particularly simple manner virtual compensation of the forces acting on the shut-off body. As a rule, such forces are a result of a pressure build-up in the working chamber. These forces act generally on the sealing ring in the direction vertical to the displacement path and counterbalance each other. On the side of the compensation chamber, a pressure build-up that could produce troublesome forces is largely prevented by the connection with the compensation chamber which at the bottom is limited by air bellows capable of absorbing volume without generating pressure.

In addition to the fact that the damping channel is designed as an annular slot and the shut-off body as a sealing ring, in principle it is also conceivable to make use of several passage openings disposed diametrically opposite each other and whose shut-off bodies are operationally connected with each other. In such an arrangement, too, by making use of the symmetry, nearly complete force compensation can be achieved. This, however, involves a considerable technical effort.

In a particularly preferred embodiment of the invention, the chamber providing the connection to the compensation chamber is attached to the additional damping channel in a radially outward direction. This has the advantage that the entire inner surface of the dividing wall is available for the placement of the membrane.

Because as a result of extensive force compensation only slight displacement forces are needed, magnetic forces can be used to actuate the shut-off body or the sealing ring. To this end, the shut-off body or the sealing ring are advantageously provided with a permanently magnetic material, and a device is provided for generating the appropriate switching magnetic fields.

The device for generating magnetic fields is preferably an electromagnet.

When the additional damping channel is in the form of an annular slot and the shut-off body in the form of a sealing ring, the electromagnet is advantageously also, at least in segments, in the form of a ring corresponding to the sealing ring.

In an especially simple space-saving design, the electromagnet is disposed in a chamber adjacent to the chamber connecting with the compensation space containing the shut-off body.

In a particularly preferred embodiment of the invention, the shut-off body or the sealing ring consists of a magnetic elastomer. The density of elastomers is usually in the range of the density of the damping liquid so that as a result of this measure the displacement forces for the shut-off body are further reduced.

The required mounting space is further minimized when the damping channel is at least partly disposed in the dividing wall between the working chamber and the compensation chamber.

In particular, the additional damping channel is sized so that it is suitable for decoupling and quenching low-frequency, high-amplitude vibrations of an idling drive assembly.

If, besides the first and the additional damping channel, the switchable assembly bearing of the invention is provided with yet another known decoupling device for quenching and damping high-frequency, low-amplitude acoustic vibrations, the switchable assembly bearing of the invention combines in itself all advantages of an idling switchable bearing in itself known, but in contrast to the known versions is characterized by a simple design, compact construction and low energy requirements.

In the following, the invention will be explained in greater detail by reference to the drawings in which:

Figures 1a and 1b show a schematic representation of a longitudinal section of a preferred embodiment of a switchable assembly bearing in the closed position (a) and with the additional damping channel open (b).

Figures 1a and 1b show a hydraulically damped assembly bearing 1 of the invention provided with a working chamber 10 and a compensation chamber 20 and which are filled with a common hydraulic fluid. Working chamber 10 is limited by a wall 3 of truncated conical shape and made of an elastic material, known as the bearing spring. Compensation chamber 20 is limited at the bottom by a cup-shaped wall 4, also made of an

elastic material, for example by an air bellows capable of absorbing volume without creating pressure. On the side of the engine, peripheral wall 3 receives bearing plate 3.1, said plate being provided with a protruding screw bolt 3.2 for fastening to the engine. Between working chamber 10 and compensation chamber 20 is located a dividing wall 50 in which is disposed membrane cage 52 for receiving a membrane 54. In dividing wall 50 is also disposed a damping channel 60 which hydraulically interconnects the two liquid-filled chambers 10 and 20. The lower limiting wall 4 of compensation chamber 20 is surrounded by a housing 4.1 on which there is provided a vertically protruding screw bolt 4.2 for fastening assembly bearing 1 on the side of the vehicle body. According to the invention, an additional damping channel 70 for quenching the idling-induced vibrations is disposed in dividing wall 50. It can be seen in the sectional representation of the present embodiment of the invention that the additional damping channel 70 makes an approximately 90° bend from the vertical to the horizontal direction and ends in connecting chamber 80 which provides the connection with compensation chamber 20. This means that in the embodiment shown, the additional damping channel 70 and the connecting chamber 80 constitute an annular slot in the form of a peripherally extending aperture. In connecting chamber 80 is located as shut-off body a sealing ring 90 made of an elastomeric magnetic material. In connecting chamber 80, sealing ring 90 is movable back and forth in the axial direction between an open position and a closed position between two studs 81, 82 acting as stops. It can be seen from Figures 1a and 1b that the displacement path of sealing ring 90 extends vertically in the direction of the mouth of additional damping channel 70. It is made certain in this manner that sealing ring 90, even if subjected to a pressure stress, can continue to move through additional channel 70 virtually without force application, because the forces acting on the sealing ring from the side of the working chamber counterbalance each other. On the side of the compensation chamber, the build-up of a pressure gradient that could lead to troublesome forces is prevented by air bellows 4 capable of absorbing volume without creating pressure. To actuate sealing ring 90 there is provided an electromagnet 100 which in correspondence with sealing ring 90 also extends peripherally and which is disposed on a chamber 85 that is directly adjacent to connecting chamber 80. In the closed position shown in Figure 1, sealing ring 90 rests on the lower stud 82 and with its internal radial surface seals the additional damping channel 70 in liquid-tight manner.

The polarity reversal of the electromagnet puts sealing ring 90 into the open position represented in Figure 1b. Said ring touches upper stud 81 thus freeing the passage opening of the additional damping channel 70 toward connecting chamber 80.

Because of its permanent magnetic properties, sealing ring 90 can be kept in the position shown without the need for a current.